

# Study of right bundle-branch block in association with either left anterior hemiblock or left posterior hemiblock using His bundle electrograms

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*His bundle electrograms have been recorded in 4 patients with sinus rhythm, right bundle-branch block, and left anterior hemiblock, and in 2 patients with sinus rhythm, right bundle-branch block, and left posterior hemiblock. The findings of a long His-Q interval in these patients suggest that there is more widespread involvement of the bundle-branches leading to trifascicular disease. All 6 patients gave a history of syncopal episodes and all subsequently developed intermittent or permanent complete heart block. It is suggested that the recording of His bundle electrograms in patients with bifascicular block is a useful technique for assessing conduction down the third remaining bundle-branch and if this is found to be impaired in patients with syncopal attacks this could constitute an indication for the implantation of a pacemaker.*

The presence of complete right bundle-branch block in association with either left anterior hemiblock or left posterior hemiblock can be diagnosed from the external electrocardiogram (Pryor and Blount, 1966; Rosenbaum, 1968). When this occurs the sinus impulse is transmitted to the ventricles via one or other divisions of the left bundle, the anterior division if the posterior is blocked and the posterior division if the anterior is blocked. Should this remaining division of the left bundle also be diseased but not totally blocked then the conduction system is at risk, and should the remaining division become totally blocked, then complete heart block will develop. In the presence of bifascicular block, disease in the third remaining fascicle should be suspected in the presence of a long PR interval or the development of second-degree heart block (Rosenbaum *et al.*, 1969). We have used the technique of recording His bundle electrograms (Scherlag *et al.*, 1969) to study patients with bifascicular block in order to assess the functional competence of the third remaining fascicle upon which ventricular activation is dependent.

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## Patients and methods

Six male patients were studied; all gave a history of syncopal episodes but when first seen the patients were in sinus rhythm. None of the patients was taking digoxin or diuretics when studied. The details of the patients and their electrocardiograms are shown in Table 1.

All 6 patients had right bundle-branch block. In addition, 4 patients (Cases 1, 2, 3, 5) had left anterior hemiblock and 2 patients (Cases 4 and 6) had left posterior hemiblock. (Right ventricular hypertrophy was excluded in these 2 patients.)

In each patient a His bundle recording was obtained. A bipolar catheter was introduced into a femoral vein by direct puncture and passed to the right ventricle under fluoroscopic control. A second bipolar catheter was passed to the right atrium via a brachial vein; this was connected to a Multitone external pacemaker and used for atrial pacing. The catheter in the right ventricle was connected to the electrocardiograph input of a Cambridge photographic recorder and in one patient to a Mingograph 34. Records were taken with the frequency response set at 80-500 cycles/sec and at a paper speed of 100 mm/sec. An external electrocardiogram was recorded simultaneously. The catheter in the right ventricle was withdrawn across the tricuspid valve until the bi- or triphasic spike of the His potential was seen between the P wave and the QRS complex of the external electrocardiogram. Bipolar and unipolar recordings were obtained. Recordings were taken while in sinus rhythm and during atrial pacing up

TABLE 1 Details of electrocardiograms taken while patients were in sinus rhythm

Patient	Age (yr)	Sex	PR interval	Mean frontal plane QRS axis	Bundle-branch block	QRS width	Complete heart block
1	76	M	0.22	-70°	RBBB	0.14	Seen on oscilloscope
2	85	M	0.20	-90°	RBBB	0.16	Seen on oscilloscope
3	62	M	0.17	-60°	RBBB	0.13	Electrocardiogram obtained
4	76	M	0.22	+120°	RBBB	0.12	Seen on oscilloscope
5	85	M	0.20	-40°	RBBB	0.14	Electrocardiogram obtained
6	75	M	0.24	+120°	RBBB	0.14	Electrocardiogram obtained

RBBB - right bundle-branch block.

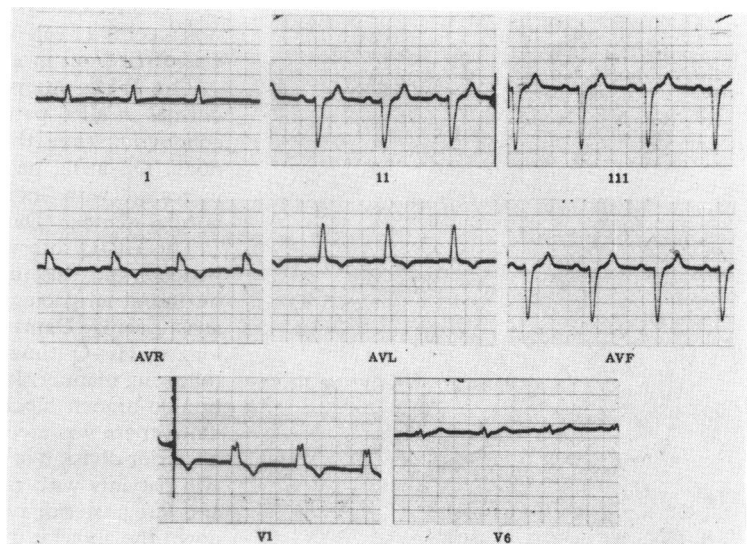
TABLE 2 Results obtained from His bundle electrograms

Case No.	P-His sinus rhythm	ST-His atrial pacing	His-Q	RR interval	Rate/min	His bundle pacing
1	139	185 204	72 72 78	775 610 465	78 99 130	RBBB pattern persists
2	120	130 145 150	98 104 100	600 598 510	100 102 119	RBBB pattern persists
3	140	220	65 65	870 600	68 100	RBBB pattern persists
4	128	—	99	690	86	RBBB pattern persists
5	120	164 187 240	71 71 70	910 630 530	65 100 115	His bundle not captured
6	83	—	95	450 600	136 103	RBBB pattern persists

RBBB, right bundle-branch block.

to a rate of 160/min. Finally in each patient the His bundle was paced using the bipolar catheter placed in the region of the His bundle and connecting it to a Multitone external pacemaker. His bundle pacing was carried out up to a rate of 160/min. The following measurements were made from the records obtained.

FIG. 1 Electrocardiogram from Case 1.



- P-His** - the time in milliseconds between the onset of the P wave on the external electrocardiogram and the first deflection of His deflection on the intracardiac recording.
- ST-His** - the time in milliseconds between the atrial pacing stimulus as seen on the external electrocardiogram and the onset of the His deflection as seen on the intracardiac recording.
- His-Q** - the time in milliseconds between the onset of the His deflection and the onset of the QRS complex on the external electrocardiogram.
- RR interval** - the time in milliseconds between two successive R waves on the external electrocardiogram.

The normal P-His interval was taken as 80-140 msec for heart rates below 80/min. The normal

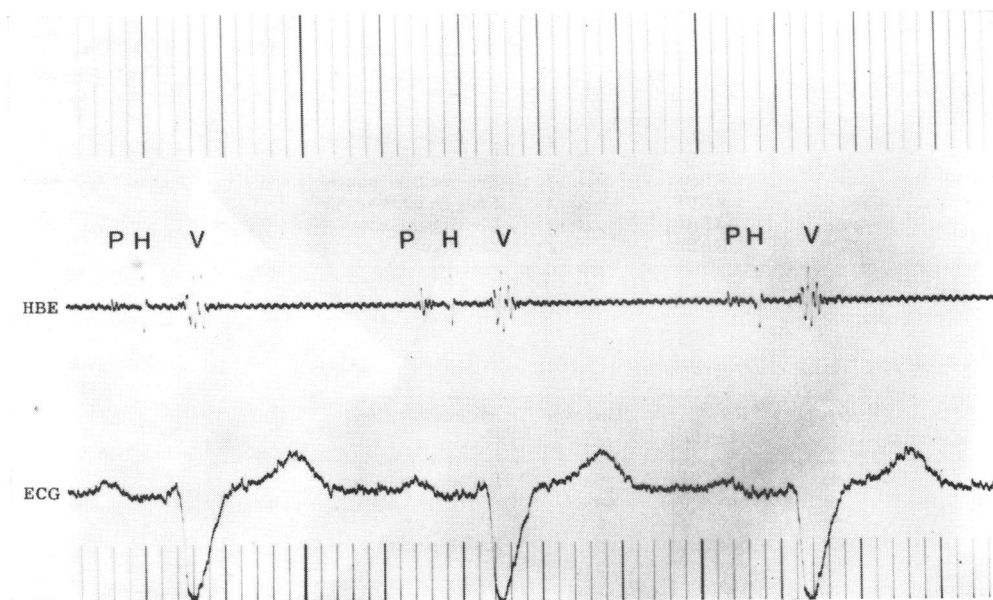
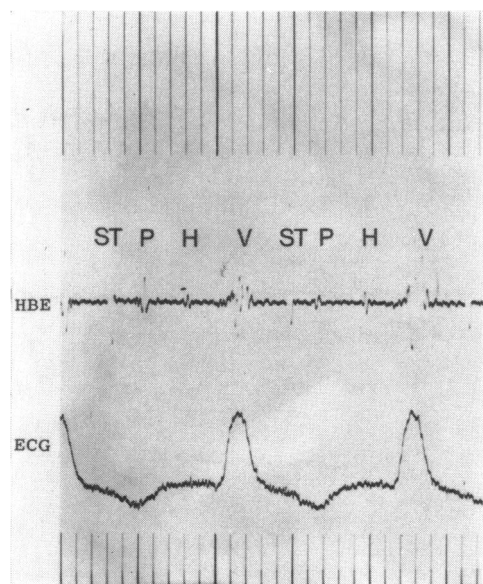


FIG. 2 His bundle electrogram from Case 1 recorded during sinus rhythm. HBE, His bundle electrogram; P, atrial depolarization; H, His bundle depolarization; V, ventricular depolarization.

FIG. 3 His bundle electrogram from Case 1 recorded during atrial pacing at a rate of 130/min. ST, pacing stimulus artefact.



His-Q interval was taken as 42–60 msec. These figures are based upon unpublished data of our own confirming reported values from Damato *et al.* (1969).

The results of the His bundle electrograms are shown in Table 2. Fig. 1–8 are His bundle recordings from Cases 1 and 2 and are explained in the text.

## Results

**His bundle electrograms** The His bundle was recorded in all 6 patients and atrial pacing was carried out in 4 (Cases 1, 2, 3, 5).

The P-His interval in sinus rhythm was normal in all 6 patients indicating a normal conduction time through the atria and AV node. On atrial pacing the ST-His interval increased with increasing heart rates in a normal manner (Damato *et al.*, 1969).

The His-Q interval was prolonged in all 6 patients and this interval remained constant during atrial pacing (the normal response to atrial pacing, Damato *et al.*, 1969). The prolonged His-Q time was interpreted in the following manner. In the 4 patients with right bundle-branch block and left anterior hemiblock there was a conduction delay down the posterior division of the left bundle and in the two patients with right bundle-branch block and left posterior hemiblock there was delay down the anterior division of the left bundle.

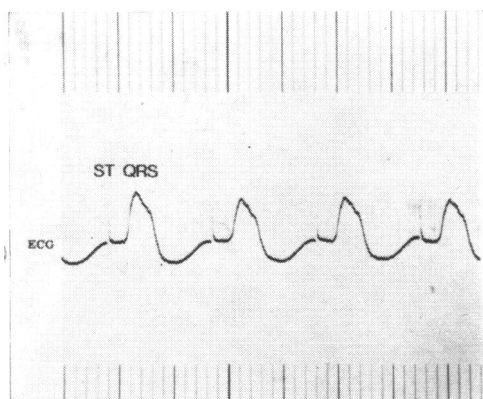


FIG. 4 External electrocardiogram (lead I) in Case 1 recorded during His bundle pacing at a rate of 160/min. Note persistence of right bundle-branch block pattern.

The His bundle was successfully paced in 5 patients, but in one (Case 5) this was unsuccessful. In all 5 patients the right bundle-branch block pattern persisted during His bundle pacing.

All 6 patients went into complete heart block while in hospital, verified either on an oscilloscope or by an electrocardiogram recording, and all 6 patients required a permanent implanted pacemaker.

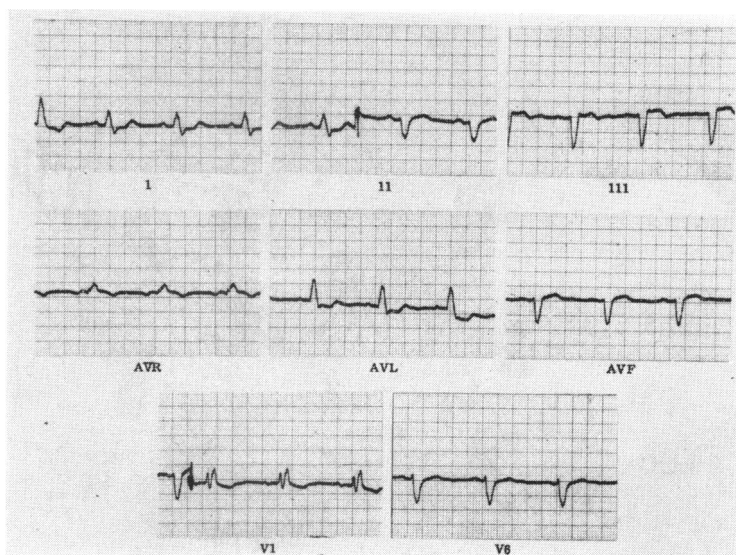
## Discussion

Conduction of the sinus node impulse to the ventricles in man takes place via the AV node, the bundle of His, and from the bundle of His it passes to the right ventricle via the right bundle-branch and to the left ventricle via the anterior and posterior divisions of the left main bundle. Complete block in either the right bundle or the left bundle can be diagnosed satisfactorily from the external electrocardiogram. Block in the anterior or posterior division of the left bundle, either isolated or in association with right bundle branch-block, can be diagnosed from the external electrocardiogram by analysis of the initial and terminal QRS vectors in the frontal plane. In left anterior hemiblock the initial QRS vector passes inferiorly and to the left and the terminal QRS vector passes superiorly and leftward resulting in a small Q wave in lead aVL followed by a tall R wave, and a small R wave in lead III followed by a deep S wave, the resulting mean frontal plane axis being greater than  $-30^\circ$ . In left posterior hemiblock the initial vector passes leftward and superiorly and produces a small R wave in lead I and

a small Q wave in lead III and the terminal vector passes inferiorly and produces a deep S wave in lead I and a tall R wave in lead III, resulting in a mean frontal plane QRS axis of  $+120^\circ$  or greater (Pryor and Blount, 1966; Rosenbaum, 1968, 1969). If in the presence of bifascicular block, first-degree or second-degree heart block is present this could be interpreted as showing either added delay of conduction between the sinus node and the bundle of His or delay down the third fascicle. Three of our patients with bifascicular block had long PR intervals suggesting delay in conduction down the third fascicle, and this was verified by the finding of a long His-Q interval. The other 3 patients showed bifascicular block only and no other evidence of conduction delay; however, the His bundle electrogram in these patients showed a long His-Q interval demonstrating further conduction delay down the third fascicle and therefore trifascicular disease.

The 2 patients with right bundle-branch block and left posterior hemiblock both had long PR intervals suggesting further conduction delay down the anterior division of the left bundle; this was confirmed by the long His-Q interval. Patients with right bundle-branch block and left posterior hemiblock are likely to have associated disease of the anterior division of the left bundle, the reason for this being that the posterior division is the least vulnerable fascicle and if diseased it suggests

FIG. 5 External electrocardiogram from Case 2.



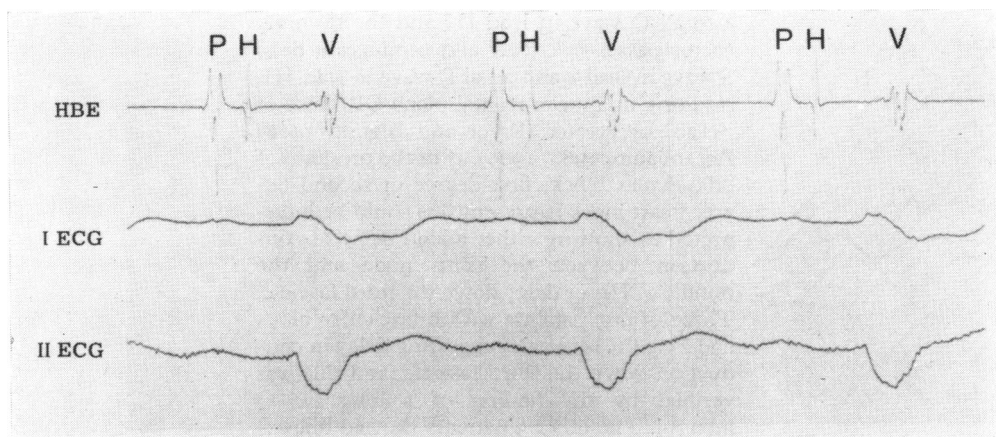


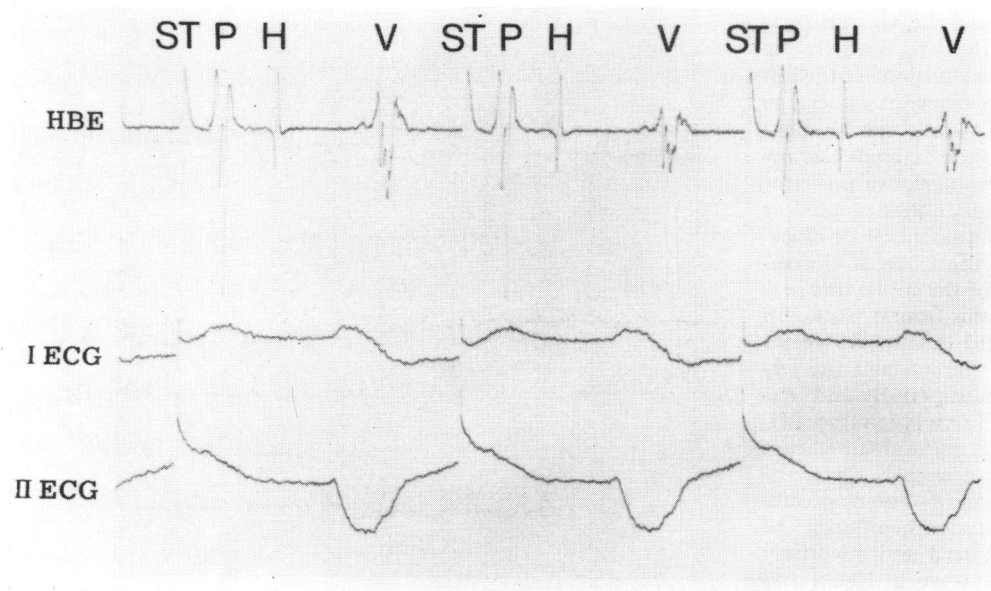
FIG. 6 His bundle electrogram from Case 2 during sinus rhythm.

that there may be more widespread lesions involving the right bundle and the anterior division of the left bundle in addition. This is further borne out by the statement that 75 per cent of patients with right bundle-branch block and left posterior hemiblock go into complete heart block, whereas only 17 per cent of patients with right bundle-branch block and left anterior hemiblock go into complete heart block (Rosenbaum, 1968). Of the 4 patients with right bundle-branch block and left anterior hemiblock, only one patient had

evidence of trifascicular disease as evidenced by a long PR interval. The remaining 3 patients had evidence of bifascicular block only, but the His bundle electrogram showed them all to have long His-Q intervals thereby demonstrating the presence of trifascicular disease.

The history of syncopal episodes in patients with right bundle-branch block and either left anterior hemiblock or left posterior hemiblock strongly suggests that intermittent complete heart block is occurring even though the

FIG. 7 His bundle electrogram from Case 2 recorded during atrial pacing at a rate of 130/min.



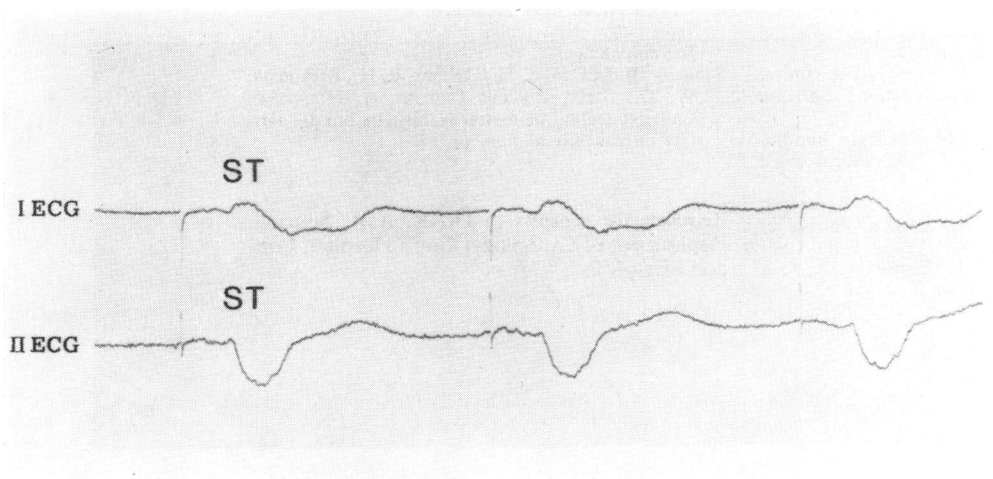


FIG. 8 External electrocardiogram (leads I and II) recorded from Case 2 during His bundle pacing at a rate of 102/min.

electrocardiogram shows sinus rhythm when the patient is first seen. Kulbertus and Collignon (1969) followed 16 patients with right bundle-branch block and either left anterior hemiblock or left posterior hemiblock. All 16 patients gave a history of syncopal episodes and all 16 patients subsequently developed transient or permanent complete heart block. The 6 patients in our study all showed bifascicular block on their cardiograms, all had a history of syncopal episodes, and all subsequently developed complete heart block. By recording the His bundle electrogram we were able to show that in this group of patients evidence of trifascicular disease was present while in sinus rhythm and therefore the risk of developing complete heart block was present. It is interesting that in 12 patients studied by Haft *et al.* (1971) by recording His bundle electrograms, 11 patients had normal His-Q intervals and 1 patient had a prolonged His-Q interval. None of the 12 patients had a history of syncopal episodes and complete heart block had not been recorded.

His bundle pacing is carried out in order to verify that the deflection seen on the intracardiac recording between the P wave and the QRS complex is the His deflection and not the right bundle-branch potential or part of the QRS complex. If the His bundle is paced, then there will be no change in form of the QRS complex on the external electrocardiogram. If the right bundle-branch or part of the ventricle is paced, then the QRS complex on the external electrocardiogram will take on a left bundle-branch block pattern (Narula, Scherlag, and Samet, 1970). In this study

pacing in the region of the His bundle was successfully carried out in 5 patients and the right bundle-branch block pattern persisted in all 5 patients, indicating that the deflection seen on the intracardiac recording was likely to be the His bundle and not the right bundle-branch potential.

We consider that the recording of a His bundle electrogram in patients with evidence of bifascicular block on their electrocardiograms and particularly in patients with a history of syncopal episodes is a valuable method for assessing conduction down the third remaining fascicle. Should the conduction be found to be delayed in this fascicle (as evidenced by the prolonged His-Q interval), then a case can be made for the insertion of a pacemaker at that time despite the presence of sinus rhythm. A history of syncopal episodes is a strong additional feature in favour of pacemaker implantation.

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